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quicker upwards than the snow-line, and from August to January quicker downwards. The snow-line therefore in the first period coincides with isothermals warmer than  $0^{\circ}$  C.; in July it is even at  $+5^{\circ}$  C. The snow-line, in the usual sense, that is to say its highest limits in summer, is, at the mean temperature of the year,  $-4^{\circ}$  C.

13. Over large masses of snow and glaciers there is remarked, particularly on fine days, a descending current of air (glacier-wind), which has a great influence on the general depression of temperature near the limits of snow.

14. The absolute extremes of cold on single days are at the lower stations sometimes so great, that they are comparatively but little surpassed by those on the higher points. But the differences between the higher and lower part are much greater if we consider the maxima of heat. The absolute maxima seem scarcely ever to exceed  $5^{\circ}$  or  $6^{\circ}$  C. on the highest summits of the Alps. On all days the decrease of temperature is greater at the time of the maximum than at the minimum.

15. Compared therefore to the temperature of high latitudes, the *summits* of the Alps correspond nearly to  $70^{\circ}$  N. Lat. But the climate of the highest elevations on the Alps is much less severe than that of Northern Asia, and is more constant than that of Polar America. Their minima of winter are much surpassed by nearly all stations in northern latitudes; but the maxima of summer are colder than those of nearly all points on high latitudes at little elevation above the sea.

A paper was also in part read, entitled "On the Exogenous Processes of the Vertebræ." By Professor Owen, F.R.S. &c. Received November 8, 1850.

The Society then adjourned over the Christmas holidays, to meet again on the 9th of January, 1851.

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January 9, 1851.

Lieut.-Col. SABINE, R.A, V.P. and Treasurer in the Chair.

The reading of Prof. Owen's paper "On the Exogenous Processes of Vertebræ" was resumed and concluded.

The author commences by a definition of these as contradistinguished from the autogenous parts or 'elements' of a vertebra, and exemplifies them by instances from Human and Comparative Anatomy, which show the necessity of a distinct substantive term for each of such parts and processes. The terms proposed are as follows:—

	<i>Names.</i>	<i>Synonyms in Comparative Anatomy (Cuvier).</i>	<i>Synonyms in Human Anatomy (Soemmering).</i>
Autogenous.	Centrum.	Vertebral body.	Corpus vertebræ.
	Neurapophysis.	— laminæ.	Arcus posterior vertebræ, seu radices arcus posteriores.
	Pleurapophysis.	— rib, cervical rib, hatchet-bone.	Costa, seu pars ossea costæ, processus transversus vertebræ cervicalis.
	Hæmapophysis.	Sternal rib, chevron-bone.	Cartilago costæ.
	Parapophysis.	Inferior transverse process.	Radix prior seu antica processus transversi vertebræ cervicalis.
Exogenous.	Diapophysis.	Superior transverse process.	Radix posticus processus transversi vertebræ cervicalis, processus transversus.
	Zygapophysis.	Articular or oblique process.	Processus obliquus seu articularis vertebræ.
	Metapophysis.	Prolongation of articular process.	Duo processus accessorii processui transverso et articulari superiori interpositi.
	Anapophysis.	Supplemental articular process.	
	Hypapophysis.	Inferior spinous process.	
	Spine { neural.	Spinous process.	Processus spinosus.
	{ hæmal.	Inferior spinous process.	

The principal aim of the present communication was to point out the proportion of the vertebrate animals in which the metapophysis, anapophysis and hypapophysis were present, their principal modifications, and their title to the distinct appellations bestowed upon them.

The metapophysis is noticed by *Monro*, in 1726, as a small rising between the roots of the superior oblique and transverse processes; and both this and the anapophysis appear to be defined in similar terms, as sometimes characterising the lumbar vertebræ, by *Soemmering*. The author of the present paper commences his comparative anatomy of both processes by describing them in the European, Polynesian and Australian varieties of the human race. He then passes to the *Quadrumana*, and traces their modifications and progressive development in the *Chimpanzee*, *Orang-utan* and *Gibbon*, in the *Cercopithecus ruber*, *Semnopithecus entellus*, *Macacus rhesus*, *Macacus niger*, *Macacus nemestrinus*, *Papio mormon*, *Ateles paniscus*, *Ateles Beelzebuth*, *Cebus capucinus*, *Callithrix sciureus*, *Lemur nigrifrons*, *Lemur Catta*, *Lichanotus Indri*, and *Stenops gracilis*.

In the order *Carnivora*, the same processes are described in the *Lion*, *Hyæna*, *Wolf*, *Fox*, *Civet*, *Genette*, *Otter*, *Sable*, *Kinkajou*, *Mydaus*, *Badger*, *Bear* and *Seal*. The presence of anterior articular processes (pre-zygapophyses) is demonstrated in all these *Carnivora*, in the anterior dorsal vertebra; and their apparently greater production in the succeeding vertebræ is shown to be due to the gradual transference of their articular surfaces upon the metapophyses, which are processes distinctly superadded.

In the *Rodent Order*, the modifications of the metapophyses and anapophyses are described in the common and *Malabar Squirrels*, the *Marmot*, the *Hydromys*, the *Rat*, the *Cape Jerboa*, in which the anapophyses attain their maximum of relative size; in the *Beaver*,

the Porcupine, the Coypu, the Paca, the Capybara, and in the Hare. The distinction between the metapophyses and the pre-zygapophyses is particularly strongly marked in the Capybara.

In the Insectivora, the Hedgehog is an instance in which metapophyses are developed but not anapophyses. The modifications of both processes are traced, in the Marsupial Order, in the Thylacine, the Dasyure, the Wombat, the Perameles, and in two species of Kangaroo. The diapophyses being developed from the last as well as the antecedent dorsals in these marsupials, renders the homology of the transverse processes of the lumbar vertebræ unmistakeable: but the diapophyses of those vertebræ are lengthened out by anchylosed pleurapophyses, of which those of the first lumbar vertebra in the Wombat, compared by the author, had not completely coalesced. In the *Ornithorhynchus paradoxus* the metapophyses are double in some of the anterior dorsal vertebræ, but become single in the sixth dorsal, and gradually increase to the twelfth. The anapophyses are rudimental.

In the Ruminant Order, the accessory processes are described in the Elk, the Giraffe, the Gnu, the Equine Antelope, the Ox, the Aurochs, the Camel, the Vicugna, the Memmina, and the Musk-deer. The anapophyses are rarely, and then only very feebly developed; the metapophyses are constant; they appear as tubercles above the diapophyses in the anterior and middle dorsals, and pass upon the zygapophyses in the penultimate or last dorsal. The author records a peculiarity in the skeleton of a musk-deer (*Moschus moschiferus*). In the pair of ribs attached to the thirteenth dorsal vertebra the tubercle is wanting, and the diapophysis is obsolete, as in the last dorsal vertebra of other *Moschidæ*; but in the following vertebra, answering to the first lumbar in other *Moschidæ*, the rib is developed with a head and a distinct tubercle, articulated to an equally distinct diapophysis. This plainly demonstrates the homology of the diapophysis in the next vertebra, answering to the second lumbar in other *Moschidæ*.

There are no anapophyses in the Hog-tribe and Hippopotamus: the metapophyses resemble those of the ruminant artiodactyles. The perissodactyle Ungulates manifest some peculiarities. In the Sumatran Tapir, *e. g.* the metapophysis is a very distinct process in the third dorsal, subsides in the four next dorsals, and reappears as a prominent process in those that follow, but does not attain the position upon the zygapophysis except in the last lumbar vertebræ. In the Horse and Rhinoceros, as well as the Tapir, although there are no proper anapophyses, the diapophysis of the last lumbar develops an articular surface on its back part which articulates with a corresponding surface on the sacrum. In the vertebræ of the Elephant a peculiarity is pointed out which is not adverted to by Cuvier or De Blainville, and appears to have escaped notice, viz. an accessory pair of joints between the metapophysis and anapophysis, commencing between the seventeenth and eighteenth dorsals, and continued to between the first and second lumbar vertebræ. The metapophyses have been undescribed, also, in the *Cetacea*, although

they are represented in the plates of the 'Ossements Fossiles' distinctly from the anterior zygapophyses, and exist in many vertebræ after these processes with their articular surfaces have wholly disappeared: the modifications of the metapophyses, and their mode and place of superseding the prezygapophyses, are described in the *Delphinus Tursio* and *D. Delphis*: their modifications are also pointed out in the Dugong. But the most remarkable development and complexity of the accessory exogenous processes is presented by certain members of the Order *Bruta* or *Edentata* of Cuvier. The author commences with a description of them in the Sloths, and gives his reasons for considering the length of the neck in the three-toed species to be due to the superaddition of two cervicals between the dentata and eighth vertebra, which, from certain characters of its complex transverse process, he regards as homologous with the sixth cervical vertebra of the two-toed species.

In the Cape Ant-eater (*Orycteropus capensis*), both metapophyses and anapophyses are present on the eighth dorsal vertebra; the former are continued to near the end of the tail, the latter subside in the last lumbar. In the armadillos the metapophyses commence abruptly about the middle of the back, and progressively increase until they equal the long neural spines in height: they develop two articular surfaces, one on the inner side of their base, another on the outer side: the latter articulates with the anapophysis, which is remarkable for its thickness, and develops a second inferior articular surface for the parapophysis, which, together with the diapophysis, is developed from all the lumbar vertebræ. These complex joints are illustrated by drawings taken from two species of Armadillo.

The exogenous processes present still greater complexity in the true Ant-eaters. The metapophyses commence in the cervical region, change their place from the zygapophyses to the diapophyses in the anterior dorsals, and back again to the zygapophyses in the posterior dorsal and lumbar vertebræ, where they supersede those processes; and develop accessory articular surfaces for the anapophyses. These not only present an upper articular surface for the metapophysis, and a lower one for the parapophysis, but develop a third outer one for a new articular surface upon the diapophysis; so that, were not the ordinary articular processes, or zygapophyses, obliterated in the posterior dorsal and lumbar vertebræ, there would be not fewer than eighteen synovial joints, in addition to the intervertebral joints, in the posterior lumbar vertebræ of the Great Ant-eater. These processes and articulations are illustrated by figures taken from the Great Ant-eater; and the necessity of the substantive names for the processes, and of adjectives to signify their added articular surfaces, was exemplified in the explanation of those figures. The peculiar complexity of the vertebræ of the Edentata having been, previously to the investigations of the author, illustrated by a comparison with those of the Serpent tribe, he next enters upon the question of the precise nature and extent of this analogy, and shows that, although the complex joints in both are comparable to the tenon-and-mortice joints in

carpentry, they are produced by different processes in the Mammal and the Reptile. The zygapophyses exist in both; to these, in the Mammal, are superadded the joints developed on metapophyses and anapophyses, which are *below* the zygapophyses; but in the Serpents, the superadded joints are on parts which the author terms the 'zygosphenæ' and 'zygantrum,' and are *above* the zygapophyses. Some characteristic differences are next pointed out in the Ophidian genera *Coluber*, *Hydrus*, *Naja*, *Crotalus*, *Python*, and the extinct genus of large serpents from British eocene strata called *Paleophis*. The author also points out that the tenon-and-mortice joints are not, as was supposed, peculiar to the Ophidian reptiles, but exist in the Iguana, where they are likewise due to the superaddition of zygosphenal and zygantral articulations.

The author finally enters upon the comparative anatomy of the 'hypapophysis,' that name being applied to the process, commonly exogenous, from the under or ventral surface of the centrum, rarely autogenous from the same aspect of the capsule of the notochord. The modifications of the hypapophysis are exemplified in the Hare and Rabbit, the Cape Jerboa, the Hydromys, the *Phoca groenlandica* and *Leptonyx serridens*, in the *Hippopotamus*, the *Megaceros*, the Musk-deer, the Camel, the Giraffe, and other Ruminants. In the *Ornithorhynchus* the atlas is remarkable for a pair of hypapophyses, like the first vertebra in the Sudis or *Arapaima gigas*: but the most remarkable instances of the development and modification of the hypapophysis are to be met with in the class of Birds. It is there well-marked in the anterior cervical vertebræ, especially in the dentata, and reappears in the lower cervicals as a pair of processes, which defend and sometimes encompass the carotid arteries, forming a quasi-hæmal arch, as in the Pelican. The still more extraordinary developments of the hypapophysis in the *Aptenodytes* and *Sphænicus* are specially described and illustrated by figures. The modifications of the same process are pointed out in some extinct Reptilia, as *e.g.* the *Crocodylus basifissus*, the Mososaurus, the Iguanodon and the Ichthyosaurus: in the latter the hypapophysis is exogenous in the neck, as in some Lizards, and forms the so-called 'wedge-bones:' the part usually called 'body of the atlas' is serially homologous with these; the true centrum of that vertebra being the so-called odontoid process. The memoir concludes with a demonstration of the serial homology of the hæmal arches of the tail, sometimes called chevron-bones, and the essential distinction of the hypapophyses from the hæmapophyses, and at the same time from the parapophyses, with which the hypapophyses co-exist in the cervical and anterior thoracic regions of the Crocodile.

The paper is illustrated with fifty-five drawings, of which detailed descriptions are appended to the memoir.

A communication was read, entitled, "Researches on the Distribution of Vegetables in the Alps compared with the Differences of Climate, and on the Periodical Development of Plants at different heights." By Adolph Schlagintweit.